Results of the first batrachian survey in Europe using road call counts

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Within the last 20 years, there have been extensive efforts to monitor populations of calling amphibians, especially in North America. One such initiative involves use of volunteers in conducting road call counts. To date, no attempt has been made to test the efficacy of this technique in Europe. This paper summarizes research involving road call counts in the Biharugra Landscape Protected Area, Körös-Maros National Park, Hungary. Seven of Hungary's 12 anuran species were identified in the study area using this method and an additional 3 species were detected by complementary visual encounter surveys. Limitations, including variations in species calling radii, extraneous noise and program resource requirements should be considered when designing similar volunteer-based road call count protocols for other regions. However, this method should be of value in many areas in Hungary and Central Europe, due to its low cost, accessibility of volunteers, and value in accurately detecting most anuran species (including *Bombina bombina* and *Hyla arborea* both IUCN Red Data Book species).

INTRODUCTION

Widespread declines of amphibian populations, often without an apparent proximate cause (BLAUSTEIN & WAKE, 1990; PHILLIPS, 1990; WAKE et al, 1991, GRIFFITHS & BEEBEE, 1992), have initiated a critical global review of the status of amphibian species (VIAL & SAYLOR, 1993) Complicating the understanding of this decline are the naturally high fluctuations of many amphibian populations (PECHMANN & WILBUR, 1994). Amphibians may also display metapopulation dynamics, with decreases in some local populations coinciding with increases in others (SJOGREN, 1991) Moreover, amphibians have been recognized as potential indicators of environmental change (VITT et al, 1990, STEBBINS & COHEN, 1995; BOWERS et al, 1998), an additional factor driving inventory and monitoring efforts. To assess the status of amphibian populations, distribution patterns and population characteristics need to be examined. However, assessments are difficult because few comparable data sets and long-term studies exist (BLAUSTEIN, 1994; REED & BLAUSTEIN, 1995) The need to establish long-term inventories and monitoring has been emphasized, both in Hungary and elsewhere (PECHMANN & WILBUR, 1994; KORSÓS, 1997).

A number of species-specific considerations may affect detection of amphibians and effective use of various survey methods. Breeding season and diurnal patterns may vary with species and site (Péchy & Haraszthy, 1997; Bridges & Dorcas, 2000). Some populations, species, or life history stages may be easily observed, while others, being more rare, cryptic or fossorial, may require refined experience or trapping techniques. In addition, many biologists believe that a few successful populations can contribute most of the reproductive output for all populations in a local area (Soulé, 1987; Pulliam, 1988; Sjögren, 1991). In these situations, surveys based on distinctive courtship vocalizations may prove to be the best possible method for detecting anuran species.

The Declining Amphibian Populations Task Force (DAPTF), now affiliated to IUCN, was established to develop programs in participating countries (Wake et al., 1991; Vial, 1991; Halliday & Heyer, 1997). The road call count (RCC) method has been a frequently chosen monitoring technique in North America because of its relative ease for volunteers, and many Canadian provinces and USA states have used similar monitoring methods (see Lannoo, 1998). However, Hungarian data are less comprehensive, and although monitoring programs do exist in Europe (Gasc et al., 1997), the RCC methodology has never been tested here.

Of the 74 amphibian species in Europe, 17 occur in Hungary, including 12 anurans (Nöllert & Nöllert, 1992). Hungary was one of the first European nations to enact legislation protecting its wildlife, with its herpetofauna protected as early as 1947 (Corbett, 1989). However, like the rest of Europe, amphibians in Hungary have not received a proportionate degree of conservation action or resource allocation compared to animal groups such as birds and mammals (Bakó et al., 1992; Puky, 2000). The IUCN (Anonymous, 1993) recognizes that this lack of knowledge is a threat to the wetland diversity of the region.

Urban and agricultural development have had profound impacts on amphibian habitats in Hungary, including the loss and alteration of lentic habitats and their historical hydrological regimes. Vigorous programs of wetland drainage and channelization of the Tisza and Körös rivers (in the study region) in the mid-1800s, primarily for conversion to arable land, resulted in loss of many ox-bow lakes (Marosi & Szilárd, 1969). Lentic habitats provided by river side channels, wooded flood plain areas and off-channel sloughs and swales have been largely eliminated. For those temporary ponds which have remained or have been artificially excavated in the Tisza River basin, eutrophication is a major problem since the traditional yearly inundations have ceased (Denisov et al., 1997). Thus, it is clear that without protective intervention, the risk of threats to amphibian populations due to, inter alia, habitat loss and deterioration, will likely increase. Although there have been some attempts to describe amphibian species and distributions in the region (Marián, 1963; Gubányi, 1992), there has been little effort to develop a comprehensive list of amphibian species in the Körös-Maros National Park (KMNP).

Currently, amphibian monitoring is a new focus of attention in Hungary, particularly with its obligations in planned accession to the European Union. Until this study, no wide scale, long term investigations have been conducted, yet there is a growing realization that especially with limited resources, monitoring populations must employ a number of techniques, including those that involve volunteers (Korsós, 1997). The goal of this study was to help standardize methods of amphibian monitoring in Hungary and to conduct an investigation on the applicability of volunteer-based RCCs in Europe, given their widespread use in North America.

STUDY AREA

The 52 000 ha KMNP in east Hungary is a mosaic of large and small habitats. It lies within the Great Hungarian Plain in one of the warmest (10-10 5°C annual mean temperature) and driest (550-600 mm annual precipitation) regions of Hungary (ANONYMOUS, 1993). Protecting the rare flora and fauna in this region is of national importance and deserves special attention (BÍRÓ, 1996) The study area, located in the 9645 ha Biharugra Landscape Protected Area, includes over 1900 ha of fishponds (fig. 1), Hungary's second largest artificial lake complex. Surrounded by vast reed beds, the ponds provide critical breeding habitats for a large number of protected bird species and for mammals, fish, reptiles and amphibians (ANONYMOUS, 1997). Owing to its rich, diverse habitat and landscape features, the ponds and surrounding marshes gained international importance and were declared a Ramsar Convention on Wetlands of International Importance Especially as Waterfowl Habitat site in 1997

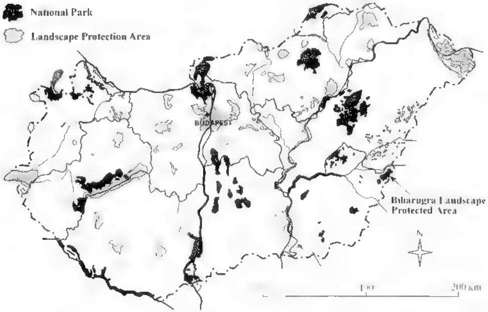

Fig 1 Location of the study area in Biharagra Landscape Protected Area of Koros-Maros National Park, Hungary

MATERIALS AND METHODS

A RCC route between Biharugra and Zsadány was selected for monitoring because of the area's unique diversity of amphibian habitats including vernal pools, drainage canals, fish ponds, wooded swamps and marshes. These habitats exist among agricultural land that focuses on wheat production and livestock grazing. Ten RCC stations were established running in a south and westerly direction from Biharugra (fig. 2).

The methodology in this research was based on the protocol developed by DAPTF Canada for Ontario, i.e., of the North American Amphibian Monitoring Program (NAAMP) specified in GARTSHORE et al. (1997). In Ontario, the route is chosen by the volunteer (thus, non-random) and ideally consists of a straight, quiet road with 10 stations 0.8 km apart, regardless of proximity to wetlands. Volunteers are requested to conduct three surveys over the anuran breeding season, corresponding with optimum weather conditions and calling periods for local species. Surveys are conducted between 30 min after sunset and midnight, with participants listening at each station for a period of 3 min, recording all anuran species heard according to the Wisconsin Index: (0) none heard, (1) individuals can be counted, no overlapping calls; (2) calls overlapping, but distinguishable; (3) full chorus, calls continuous and overlapping. Supplementary information including time, air and water temperatures, wind speed, and land use are also recorded.

In this study, I carried out RCCs between 6 March and 29 April 1998, using the Ontario methodology with the following modifications: (1) European species were identified according to the audio reproductions of anuran calls by ORSZÁGH (1982) and ALSCHER et al. (1998); (2) RCCs were conducted on 19 evenings instead of the suggested three to attempt to detect calling intensities of each species over the breeding season; (3) if present, extraneous noise was described for each location; (4) a 60 s, instead of 30 s, waiting period was used after alighting from the vehicle or following traffic noise before beginning or resuming the survey; (5) air temperatures were taken at the start and finish of each survey, with the mean value presented (fig. 3). As MOSSMAN et al. (1998) noted, measuring water temperature was time-consuming for volunteers. In this study, it was taken once per survey at station 6 to serve as a general indicator only.

To determine how well the RCC detects species presence, visual encounter surveys (VES) were conducted on two evenings (15 and 25 April) at four shallow ponds (fig. 2) located near the RCC stations (pond A, 450 m from station 2, 0.25 ha; pond B, 100 m from station 10, 0.56 ha; pond C, 60 m from station 10, 0.001 ha; pond D, 1100 m from station 10, 0.8 ha). These ponds were selected due to their easy access and because anurans were calling from these locations during the RCCs. During these evenings, RCCs were conducted, recording species heard directly from ponds A (station 2), B, C and D (station 10). Immediately following these RCCs, thorough VES were conducted around the perimeter of the ponds as recommended by THOMS et al. (1997). A survey was first conducted around the shoreline examining the pond littoral zone, followed by a second walk about 1.5 m from the shoreline, encompassing a 3 m wide sweep of the riparian zone. During these walks, stops were made every 2-3 m to scan ahead for any anurans. This method also allowed detection of species calling underwater or among thick vegetation. Only adults were recorded.

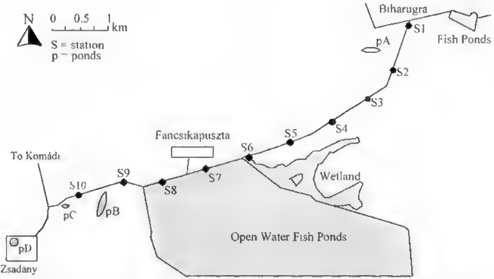

Fig 2 - Road call count route, including stations and study pond locations. Geographical coordinates of stations and study ponds (ANONYMOUS, 1995*a-b*) (S1) 21°35'32"E, 46°57'45"N, (S2) 21°35'22"E, 46°57'20"N; (S3) 21°35'02"E, 46°57'02"N, (S4) 21°34'30"E, 46°56'48"N, (S5) 21°33'54"E, 46°56'36"N, (S6) 21°33'19"E, 46°56'27"N, (S7) 21°32'42"E, 46°56'19"N, (S8) 21°32'05"E, 46°56'12"N, (S9) 21°31'32"E, 46°56'12"N, (S10) 21°30'55"E, 46°56'03"N, (pA) 21°35'11"E, 46°57'31"N, (pB) 21°31'00"E, 46°56'03"N, (pC) 21°30'50"E, 46°56'04"N; (pD) 21°29'45"E, 46°55'31"N

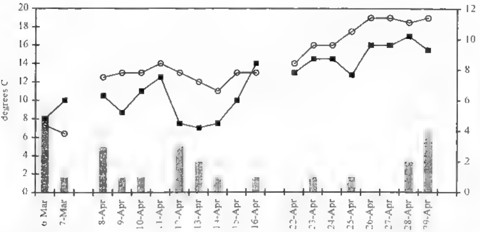

Fig 3 Beaufort Wind Scale values (shaded bars) and mean air (darkened squares) and water temperatures (open circles) during RCC.

Results

Road call counts

Seven of Hungary's 12 anuran species were detected at RCC stations along the Biharugra route. *Bombina bombina*, *Bufo viridis*, *Hyla arborea* and *Rana esculenta* were each recorded at all 10 stations (tab. 1). These four species were also heard on more evenings than any other species. Number of species recorded at each station ranged from 4 to 7.

Environmental parameters

Maximum Beaufort Wind Scale (BWS) values, and mean air and water temperatures for each RCC are shown in fig. 3. BWS values ranged from 0 to 5 (mean 1.4). Although air temperature ranged from 7.0 to 17.0°C and water temperature from 6.5 to 19.0°C at station 6 during the surveys, the onset of anuran calling was characterized when air and water temperatures first reached 10.5 and 12.5°C, respectively. However, anurans continued calling even when temperatures dropped below these values during the research period (e.g., 13-14 April).

Duration of RCC

Mean time taken to conduct an individual RCC, including the observation period at each of the 10 stations, allowing time for driving and additional waiting periods in lieu of traffic noise, etc., was 75 min (*s* 18.8; range 50-110).

Visual encounter surveys

Adults of 10 of Hungary's 12 anuran species were detected during the VES (tab. 2). In some cases, due to calling underwater or among thick vegetation, individuals were heard during the VES but not seen (i.e., *Pelobates fuscus* at ponds A and C, *Bufo bufo* and *R. esculenta* at pond B).

Discussion

My road call counts revealed that anuran species richness in the Biharugra Landscape Protected Area is almost two-fold greater than the KMNP Management Plan indicated. This richness includes *Hyla arborea* and *Bombina bombina* – both IUCN International Red Data Book species (Baillie & Groombridge, 1996). In itself, this would be a sufficient reason to encourage the use of RCCs in other areas of the KMNP, as well as other national parks. Minimally, the use of RCCs in Hungary might be used to locate breeding amphibian populations to target for more intensive survey strategies, thereby limiting the number of sites that need to be surveyed. Indeed, the Zsadány pond (pond D) was located in this fashion (i.e., anurans calling in this pond, including the two IUCN listed species above, were heard from RCC station 10 – over one kilometre away).

Table 1. – Percentage of evenings anuran species heard at RCC stations during research period. † IUCN Red Data Book (BAILLIE & GROOMBRIDGE, 1996). * Bern Convention Appendix II (ANONYMOUS, 1994). ‡ Diminishing over European Range.

Species	Station										*n*
	1	2	3	4	5	6	7	8	9	10	
Hyla arborea † *	88	77	71	71	59	47	47	71	65	71	10
Rana esculenta	35	29	41	47	41	59	47	71	59	29	10
Bombina bombina † * ‡	41	47	53	41	41	47	12	41	47	47	10
Bufo viridis *	77	53	24	6	18	24	18	71	53	77	10
Bufo bufo	0	0	0	0	29	29	6	6	0	0	4
Rana ridibunda	0	0	0	0	12	12	0	29	12	0	4
Rana lessonae	0	0	6	0	0	0	0	6	0	0	2
Total species / station	4	4	5	4	6	6	5	7	5	4	

Table 2. – Comparison of species observed during visual encounter surveys (V) and road call counts (R). * Species heard only, not seen during visual encounter surveys.

Species	Ponds							
	A		B		C		D	
	15 April	25 April	15 April	25 April	15 April	25 April	15 April	25 April
Bombina bombina	V	VR	VR	VR	VR	VR	VR	V
Pelobates fuscus	V*	V*		V		V*		V
Bufo bufo		V		V[1]				
Bufo viridis	VR	VR		VR			V	V
Hyla arborea	VR	VR	VR	VR			VR	VR
Rana arvalis				V				
Rana dalmatina	V		V	V	V		V	V
Rana ridibunda							V	V
Rana lessonae		V						
Rana esculenta		VR	V*	VR			V	VR
Total species / survey	5	7	4	8	2	2	6	7

A prime issue to consider is the discrepancies observed between species reported by the two survey methods. The VES confirmed all seven species observed with the RCC method, but also detected three additional species not heard in any of the RCCs along the route: *P fuscus*, *Rana dalmatina* and *Rana arvalis wolterstorffi*. These species were probably not heard during the RCCs because they call underwater, severely restricting detection distance (Országh, 1982, personal observation), and the RCC stations were all more than 50 m from the ponds surveyed by VES. For European anuran species, inter-station distance, call phenology and detection radii should be further investigated in varying habitats (including different assemblages and species natural histories) to determine the likely maximum distance required between RCC stations. A protocol of this nature should also account for frogs with relatively large inter-individual calling distances (e.g., *H. arborea*) to maintain independence of data and avoid double-counting. Furthermore, because human participants generally choose their own routes in volunteer-based RCCs, the sampling design is non-random, resulting in an obvious bias to choose routes where known anuran populations are currently calling, and neglecting inactive sites that potentially could develop future breeding populations. This might produce false estimates of declines by ignoring increasing populations. Conversely, although extensive (random or random-stratified) RCCs may give more accurate indications of breeding population trends, more observers are needed and the latter are more reluctant to conduct randomly selected routes due to the large number of "zeros" likely to be encountered an admittedly important limitation with random route selection (Mossman et al., 1998; Weir & Mossman, in press). As in the North American Amphibian Monitoring Program, striking a balance between hearing the most species during a RCC given the variation in calling distances, and the willingness of volunteers to spend time monitoring anurans is of utmost importance.

In the case of *R. dalmatina* and *R. arvalis wolterstorffi*, the field season may have begun too late, as these are relatively early breeders (Péchy & Haraszthy, 1997) suggesting that the first survey should be conducted in late February or early March. Corresponding with air and water temperatures and life histories of the species present (Péchy & Haraszthy, 1997), three periods are suggested to carry out future RCCs in the study area: early March (*R. dalmatina*, *R. arvalis*), mid-April (*B. bombina*, *B. bufo*, *B. viridis*, *P fuscus*, *H. arborea*) and mid-May (*R. esculenta*, *R. ridibunda*, *R. lessonae*). More data may be needed to refine this seasonal surveying regime.

An additional limitation with this technique is associated with extraneous noise at RCC stations where birds were calling in large numbers, where frequent traffic noise was experienced, or when wind speed exceeded 20 km/h (BWS > 3). These surveys took longer to conduct and were more frustrating, indicating that volunteers should also be encouraged to choose routes which have minimum extraneous noise from wind, barking dogs, birds, etc. A second factor relating to extraneous noise involves calls of other animal species that sound similar to local anurans. Alscher et al. (1998) demonstrated that both the European nightjar (*Caprimulgus europaeus*) and the horse cricket (*Gryllotalpa gryllotalpa*) emit sounds similar to the territorial call of the green toad (*B. viridis*). The distributions of both of these non-anuran species extends throughout Hungary (Bakonyi et al., 1995), and during the VES conducted at pond D the green toad and the horse cricket were heard calling simultaneously. Therefore, improvements to this protocol should include descriptions of other calling species on instructional materials, and techniques to differentiate these calls. Given the limitations, calling surveys are unreliable for detecting relatively quiet species or explosive breeders, such as *R. temporaria* and *R. arvalis*, when calling is limited to a short time period (ZIMMERMAN, 1994; PÉCHY & HARASZTHY, 1997; BOWERS et al., 1998).

For many species, however, calls are useful to locate breeding populations, and can be used to detect species presence or estimate the relative abundance of breeding males. On a number of occasions, due to calling underwater or among thick vegetation, *P. fuscus*, *B. bufo* and *R. esculenta* were only detected by sound during VES and not seen, suggesting that in cases where stations are located relatively close to calling individuals, RCCs may be advantageous in detecting species that are cryptic, low in number, or call underwater. This may also hold true for species such as *H. arborea* which have relatively long inter-individual calling distances but migrate during the day from breeding ponds to surrounding vegetation where they can be difficult to see (ORSZÁGH, 1982, personal observation). RCCs can be an effective monitoring tool, especially at sites where visual surveys conducted by walking are logistically difficult, such as: (1) large wetlands; (2) montane lakes with inaccessible shorelines, (3) lakes and wetlands with either soft-bottomed substrates, coarse substrates or extensive woody debris; (4) inaccessible privately owned land. Moreover, when set up as permanent sample sites, RCC routes can yield valuable data not only on local amphibian populations, but also on concurrent changes in habitat components if habitat types are recorded along with data on the species being investigated (COOPERRIDER et al., 1986). These surveys can be conducted by volunteers, and training tapes and manuals make it possible to involve even inexperienced observers (SHIROSE et al., 1997). Conversely, other more comprehensive surveys, including VES, require more expertise, are intrusive in nature, and demand greater levels of time and resources.

Validation of amphibian monitoring programs has been hotly debated at various levels (SHIROSE et al. 1997, DUBOIS, 1998, HEMESATH, 1998). Canadian amphibian monitoring programs have evaluated the accuracy of audio surveys (BERRILL et al., 1992, BISHOP et al., 1997; SHIROSE et al., 1997). Most significantly, these have shown that although calling intensity cannot be considered a true constant-proportion index of abundance, they can be a useful index for populations below a certain size, and to identify trends over extended periods of time. Hence, their potential use in Europe should include analysing species presence/absence at each station, or grouped stations to record trends, with multi-year data sets. HEYER et al (1994) recommended this technique should complement other alternative monitoring methods such as egg or larval counts, or mark-recapture studies, but BEEBEE (1983) pointed out that such methodologies have their own sets of problems. Nonetheless, parallel trends among several techniques can increase the credibility of conclusions drawn from monitoring efforts. MOSSMAN et al. (1998) accurately indicated that when planning such volunteer-based monitoring programs, competent long term co-ordination must be maintained, dealing with issues including program promotion (e.g., volunteer encouragement), creation of concise and easy-to-understand instructional materials, data compilation and verification, quality control, report generation, and responding to volunteers' enquiries. This crucial component is imperative during the planning phase of any prospective RCC program.

CONCLUSION

The extent of amphibian distributions in Hungary is poorly documented (GASC et al., 1997). Previous to this study, the KMNP Management Plan recognized only four amphibian species in the Biharugra Landscape Protected Area. However, my RCCs revealed almost two-fold greater anuran species richness including *Hyla arborea* and *Bombina bombina*, both IUCN International Red Data Book species. A national volunteer-based monitoring program employing RCCs, recognizing both their limitations and benefits, would not only be an appropriate complementary approach to monitor taxa indicative of habitats (FARAGÓ & NEMES, 1997), but would also encourage the public at large to conserve and enhance biodiversity to a greater extent across all areas, not just restricted biotopes in protected areas.

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